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China National Climate Committee.

OUTLINE OF NATIONAL CLIMATE PROGRAMME OF CHINA

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of

National Climate Programme of China (1991—2000)

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Outline of National Climate Programme of China

(1991—2000)

Edited by

China National Climate Committee

China Meteorological Press

FOREWORD

Climatic change has been an issue of great concern for the international society and since the 1970s this issue and the associated impact upon the economy and society have been a central topic at a series of international conferences. Following the World Climate Programme set down at the 1979 World Climate Conference hosted by the WMO, a number of developed countries have worked out their own national climate programmes.

The foundation of the China National Climate Committee (CNCC) in 1987 marks a new enhancement of the scientific and technological force in the major battle field for the progress of the economy and society of the country. As pointed out by Dr. Song Jian, the State Councillor and president of the State Science and Technology Commission of the P.R.C., China is now challenged, like other countries, by population explosion, resource shortage and environmental deterioration in its development and advance. Their solutions are obviously bound up with the climatic conditions of the nation. Apart from the compilation of the blue book of China's «Climate», the CNCC has as its major task the formulation of the «Outline of National Climate Programme of China», which aims at the settlement of the climatic problems that have substantial influence on the development of the economy and society in a combined effort of experts of relevant departments by investigating the law of climatic change, predicting its trend, managing its resources and preventing the disasters related to climate. During this process of endeavor, Chinese scientists will take an active part in the international activities concerned.

The present «Outline of National Climate Programme of China» was drawn up by a panel of experts of the CNCC. Its first draft was examined at the Second Plenary Session (Enlarged) of the CNCC in April, 1989, and afterwards it was revised three times following the suggestions and comments of relevant departments, councils and specialists, and at the end of 1989 it was adopted as the first national-level document for the climatic undertaking of the country at the meeting of the CNCC members then in Beijing.

In drafting the document reference was made to the WMO's World Climate Programme and corresponding plans of some countries. The present programme outline was accomplished in accordance with the actual situation and

scientific/technological conditions of our country and it is thus imbued with its characteristics and will be feasible.

The programme outline includes two overlapping periods: 1991 — 2000 (period for its long-term strategic objectives) and 1991 — 1995 (period for the tasks to be fulfilled during the Eighth Five-Year Plan of China).

It is convinced that the «Outline of National Climate Programme of China» will play its important role in coordinating and directing the activities in association with climatic undertaking of various departments and will provide the subcommittees under the CNCC with a basis for the drawing-up of their specific programmes.

In the compilation of the outline have been systematically summarized the advantages and weakness of our undertaking, which will make it possible for us to give full play to our strong points and to get rid of our weak ones through various kinds of assistance of the WMO and other member countries and their cooperation.

China National Climate Committee
March 1990

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INTRODUCTION

I. Significance

Climate is one of the major problems of scientific interest and has been a great concern in the world. A series of conferences on environment, food, water and energy resources held by U.N. in the 1970s declared repeatedly that because of its complexity, variability and vulnerability, climate has become one of the difficult and central subjects in association with the fate and prospect of mankind.

Since the 1970s there have been frequent climatic catastrophes on the globe, e.g., floods, cool injuries and especially the persistent large-scale droughts that have made a few hundreds of millions of people suffer from starvation or malnutrition. The 1979 World Climate Conference indicated in some of its reports that the annual economic losses due to natural calamities came to as much as 40 billion and more U.S. dollars, of which more than 65% was caused by disasters of the weather and climate source.

The atmosphere is being increasingly polluted because of the world's population explosion and the rapid development of its economy. For instance, the rise of atmospheric temperature, resulting from the increasing content of the greenhouse gases including CO_2 , will bring about serious consequences. The excessive deforestation, reclamation of land and grazing are drastically damaging natural vegetation, which is responsible for the acceleration of desertization under the condition of droughts. It is estimated that the world's cultivated area will be decreased by $\frac{1}{3}$ owing to desertization, loss of soil and water by the end of the century. All these calamities will exert far-reaching influence on our descendants.

The problem of climatic change is not confined to a country and involves the scientific and technological circles and many departments of production. The World Climate Programme formulated in 1979 by WMO and other international organizations concerned aims to coordinate efforts to jointly monitor climatic change, investigate crucial problems, propose response strategies and thus provide reliable basis for the consultations among governments. And thereupon each government is responsible for the formulation of the policies of the development of science and technology of the country itself and for the

world's progress in order to protect the priceless atmospheric environment and climate resources in the interests of mankind in a combined effort.

A lot of countries are directing efforts to set down the climate programmes of their own to explore laws of climate evolution, predict the trend of climate change in the future, manage and utilize the climate resources properly, prevent climatic disasters, in order to make contribution to the development of their national economy and play a proper role in the international activities.

China is marked by vast territory with a complicated terrain features, multiple types of climate and frequent occurrence of natural disasters. For the sake of the development of its economy further climatological investigation must be done with a view to rationally exploiting, utilizing and efficiently protecting its climatic resources, and predicting and preventing the frequent calamities of climatic origin that influence badly industrial and agricultural production and often cause loss of life and property. Furthermore, like other countries, China should make contribution to the formulation of major policies of the world's science and technology. For this reason, the formulation of the present climate programme is an essential and urgent task.

II. The Status Quo

The climatic work has taken on a new look on a global basis since the First World Climate Conference held in 1979. A climate-monitoring network in an initial form has been established, and substantial progress has been made in climate research and service. It is planned that the Second World Climate Conference is to be held in 1990, at which the participants will hold consultations and make exchange of views over the problems and policies of science and technology in association with climatic issues.

Since the foundation of the P.R.C., meteorological, hydrological and oceanic observation networks have been set up one after another, with remarkable success in their operation and surveys in these scopes. Substantial advances have been made in China of the long-term prediction, eastern-Asian atmospheric circulation, agroclimatology, hydrology and oceanology. In particular, China has abundant historical data of climate, which has drawn much attention of the climatologists of the world. All these represent favorable conditions for the performance of the National Climate Programme.

However, China's technological equipment in this field is relatively less advanced compared to that of developed countries. So far, there has been a limited number of stations in the Qinghai-Xizang Plateau, high mountain areas, immense deserts and seas, and the normalized observation network has not

yet been set up that is responsible for monitoring the atmospheric constituents of concern, e.g., CO₂ and O₃. The development and application of numerical climatic models were begun in China later than in some other countries and the research of dynamic climatology and climate prediction needs to be enforced. On the other hand, although available in large quantities in our country, the basic data are kept in many units in various formats and carriers. It is worth noting that the application of satellite data in the climatic field remains a rather weak point.

III. The Components of the Climate Programme

The World Climate Programme (WCP) based on long-term preparation and marked by a rational structure and definite objectives represents a specific programme of scientific nature and thus an original version for the formulation of a state-level climate programme for a country. In the light of the WCP, the National Climate Programme of China (NCPC) has been worked out with its realistic conditions and peculiarities considered as much as possible.

The NCPC consists of five subprogrammes with the Climate Data Subprogramme as foundation. The Climate Research Subprogramme is an important means to improve the understanding of climate formation, evolution, and the role of its factors, and to advance the prediction skills. The Subprogramme of the Tropical Ocean and Global Atmosphere (TOGA) represents a specific part of the NCPC. The Subprogramme of Climate Application is concerned mainly with the improvement of the applicability level of climate resources in the departments related to production and daily life of the public, e.g., agriculture, water conservancy, energy problem, transportation and land renovation. The Climate Impact Research Subprogramme is devoted chiefly to the study of the effect of human activities upon climate and its gross influence on the socio-economic development, to make it possible for our government to plan and direct such development in an effective way.

IV. Strategic Targets

The NCPC's strategic objectives for 1991-2000 are:

1. To further understand climate features of the country as a whole and its regional features so as to offer a basis for better exploitation of its climate resources and prevention of the disasters, and aid in its four modernizations,* especially in agricultural aspect.

* It is the abbreviation for the modernizations of industry, agriculture, science and technology, and national defence.

2. To investigate the regularities of climate change, and perform numerical study of climate for advancing the climate prediction on the basis of monthly, seasonal, interannual, multi-year scale and even longer-term scales in order to provide reliable basis for the prevention of climatic catastrophe and formulation of economic programmes.

3. To monitor the climatic environment, including the changes in its subsystems, and acquire a new set of observations through the establishment of a multi-purpose nationwide climate-monitoring network composed of space-sensing and ground-based observation facilities on the basis of the monitoring networks in the possession of different departments.

4. To explore the present bearing capacity of the atmospheric environment, gain insight of the likelihood of climate anomalies and propose a set of measures of protection and rational utilization of climate resources.

V. Tasks in the Eighth Five-Year Plan Period (1991-1995)

In the period of 1991-1995 as the first stage of the performance of the Climate Programme major efforts will be directed towards some fundamental projects and applied items in urgent need, according to the facilities, skill level and national power.

1. Relevant departments will set up and enhance their own data bank with the normalization of the climate monitoring scheme and data to be accomplished to realize mutual utilization and sharing of the data.

2. Efforts will be coordinated to make advance in the subjects of immediate and crucial interest for the country.

3. Further exploitation of the climate data, information and research resources available should be carried out in favour of production and other activities.

VI. Organizations Responsible for Implementation of the NCPC

As indicated by WMO, a national climate programme is not an independent entity but a unit that leads relevant efforts towards a common goal through its coordination, direction, and promotion, and hence all the disciplines and departments involved in the programme will gain their expected results and give play to their gross effect in the development of climatic work.

China National Climate Committee consists of the leading members and experts of relevant departments and branches, with its secretariate in State Meteorological Administration (SMA), Beijing. The Subprogramme of Climate Data is coordinated by the SMA National Meteorological Center, the Subprogramme of Climate Application by the Academy of Meteorological Science,

SMA, the Subprogramme of Climate Impact Research by the Academy of Environmental Sciences, the State Environment Protection Agency, the Subprogramme of Climate Research by the Institute of Atmospheric Physics, Academia Sinica, and the Subprogramme of TOGA by the Division of Science and Technology, State Oceanic Administration. All these units responsible for the coordination will be in charge of the formulation of their own nationwide programmes with the initiative of the related departments and branches to be launched in carrying them out.

VII. Major Measures

1. The National Climate Programme involves a wide range of disciplines and departments and, besides, it is confronted with a lot of problems, e.g., non-standardized data formats, collecting schemes, and irrational distribution of the stations because of their existence as separate systems, loose contact and lack of frequent exchange of information for the past decades. For this reason, emphasis will be placed on the coordination and exchange among operational units to make the monitoring and data-collecting systems benefit to each other.

2. Major efforts of multi-disciplines and multi-departments will be directed towards the climatic problems of common concern to achieve greater progress through cooperation in research. The departments in close dependence on climate, e.g., agriculture, forestry, water conservancy, energy production and the economy planning branches, will direct, participate or aid in climate research and extension of application of climatic products with a view to better exploitation of climatic resources and substantial reduction of disasters.

3. Relevant laws and regulations are to be formulated step by step as regards the exploitation, utilization and protection of climate resources.

4. A certain amount of up-to-date equipment is needed to gather and rapidly process the huge volume of information in the implementation of the Climate Programme. A system of computers with one having the speed of more than 10^8 operations per second as the host is currently in urgent need, and under consideration.

5. The National Programme as a part of the World Climate Programme has as one of its objectives timely collecting global data, gathering information on the recent developments of the world's science and technology, introducing them into China and promoting academic exchange on a worldwide basis.

6. Where the climate is of pronounced regionality and locality, the pro-

vince-, city- or prefectural-level meteorological institution is encouraged to formulate, in accordance with the National Programme, a climate subprogramme characteristic of its own features in a combined effort.

7. Services, including consultation-giving, are to be started, extended and improved in this field.

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NATIONAL CLIMATE DATA SUBPROGRAMME

I. Significance

Applications, impact and research of climate are all based on climate data. The state-run macro-management of agriculture, water and energy resources, and the formulation of a long-term plan in economic departments sensitive to climatic changes call for normalized data series of various densities, lengths and requirements. Therefore, the National Climate Data Subprogramme represents the important foundation for carrying out the National Climate Programme.

Nowadays, the application and research of climate cover a wide range of subjects and fields and thus the data scope is being expanded to involve the whole climate system consisting of the atmosphere, oceans, land surface, cryosphere and biosphere, instead of being limited only to conventional meteorological observations. Hence, to provide timely exchangeable data in standard format will undoubtedly be of much help to the advance of the numerical simulation and prediction of climate, and the data will serve as a reliable basis for the strategic decision of the government and its economic departments.

II. The Status Quo

1. The working system of climate data consisting of two levels, i.e., the state- and province-level, with the former run by the Climate Data Section, the National Meteorological Center (NMC), SMA and the latter by the corresponding units of weather bureaus or centers in the provinces, has been working properly with considerable progress made in recent years.

So far, an initial-form real-time meteorological data bank, and a preprocessing system have been established in the NMC, with microprocessing systems available in the province-run units. Besides, the foundation has been laid for the informationization of climate data. Automatic processing has started to take shape in China.

2. The Department of Water Conservancy has begun to establish, step by step, a network of distributed hydrological data banks across the country with data from rainfall and hydrological stations of the nation included in the «Year Book of Hydrology in China» compiled by its division of hydrology. The State

Oceanic Administration is responsible for collecting and storing marine hydro-meteorological data in vast quantities. The departments and branches of agriculture, forestry etc., have begun data bases of vegetation and soil around the country. In addition, data banks have been founded in research institutes and within some universities and colleges for research purposes.

3. The development of satellite meteorology in China has made possible the collection of meteorological and underlying surface data.

A gap exists between China and some advanced countries, which is displayed in the following aspects;

1) The lack of up-to-date facilities for collecting climate data. Now, the observing stations are too meager in the vast expanse of oceans, deserts and mountainous regions to exhibit the real state of affairs of the climate of various scales in the country.

2) The relatively feeble ability of the data-informationization programming and automatic data-processing, which cannot fully meet the needs of users, nor can the data provision for different items and lead time scales in the applications, impact and research of climate.

3) The imperfection of the management system of climate data. At present, data of meteorological source and the other subsystems of the climate system are kept and controlled in separate branches and departments. Being diversified in format and unitemized in details, these data are hard to draw on for the sake of general use without particular treatment. Further, the operational contact will be enhanced among such departments as meteorology, hydrology, ocean and environment, and much is left to be desired in making it possible to use their data mutually.

III. Strategic Targets

1. A best-organized nationwide climate monitoring network will be formed through enrichment and coordination of the current climate monitoring network run by different departments. The ground-based observation system will provide representative data of meteorological and hydrological element fields and the space-based system will furnish the globe-evenly-covering data to get rid of the deficiency of data in such regions as the vast expanse of oceans, deserts and mountain areas. To improve the vertical resolution of the atmosphere for deriving relevant climate data an additional experimental network of stations will be founded over mountain areas, deserts, cities and oceans with the aid of the unmanned meteorological and hydrological stations and oceanic buoys.

2. A data bank of a global climate system will be established with tapes as carriers. The information format of the components of the general climatic system is to be standardized so as to form a unified retrieving system.

A nationwide type-compatible computer network will be set up to realize the multi-distributed data banks of the climate system.

3. The capacity to process and analyse monitoring data is to be enhanced. The centers of data and other services of the departments of meteorology, oceans, hydrology and environment will furnish in time standardized-format climate data and a wide range of products, as of radiation, hydrological balance, ice and snow cover, biosphere and marine hydrology, and the professional use of processed products will be extended.

4. It is planned to develop a series of standardized technical guides to form a complete system for the scientific management of the observing/monitoring network, data banks, data processing/administering, and service-providing for users.

IV. Major Tasks in the Eighth Five-Year Plan Period (1991 — 1995)

The establishment of climatic data bases and operation of the climate monitoring system represent two major tasks in this period.

1. Establishment of data banks

1) To improve the existing system of collecting and transmitting data of the atmosphere, oceans, hydrology and environment in China, and to strengthen the ability of communication and to realize step by step the way data are transmitted through a data communication network with a view to getting the collection/treatment done in a minimum possible period of time. In addition, the quick inquiry and session over the computer network will be made reality as soon as possible, in order to warrant the quality of real-time data collected.

2) To improve the management system of climate data and to establish the standardized carrier and format of the data throughout the country by solving related problems.

3) To further explore the digitization of climate data, to find ways for climatic data of various forms, e.g., in digits, words and figures/tables, to be informationized, to accelerate historical data informationization and preprocessing, and to enhance the collection and treatment of the data concerning the frequency and intensity of extreme climatic events in the records.

4) To speed up the establishment of the preprocessing system of climate data and automatic processing system of meteorological data in order to set up

the global-data tape bank and a service system with the tape retrieval as its main form.

5) To begin a data base system with a view to i) perfecting the real-time data bank and enhancing its function in retrieving and invoking, and ii) founding data banks of various types on purpose to gradually establishing the nationwide distributed bank network on the basis of state-run data communication network in order to realize the common share of these data.

2. Establishment of the operational climate monitoring system

1) To set up a management system of data bank for climatic diagnosis that contains not merely the data set of precipitation, temperature, hydrology and upper-air items of the climate data base but the set of the meteorological satellite products, e.g., OLR, SST, sea ice, snow cover, vegetation index, soil moisture and cloud parameters, and the forecasting products, such as physical quantity fields and characteristic quantities of atmospheric circulation, as well.

2) To found a management system of climatic diagnostic analysis and to provide the information of large-scale climate system.

3) To start a management system of climatic diagnosis services that will be responsible for offering files of consultant and record services, and output of graphics of various products, and for issuing the bulletin of monthly or seasonal global climatic diagnosis and report of special climate likely to occur.

To accomplish the two major tasks, the following is scheduled.

1. To establish a retrieval system for climate data, i.e., the one for the catalogue retrieval of historical record of atmosphere, oceans, hydrology and environment, etc., and to set up data bases for the historical evolution of the stations in the various observing systems, whereupon to found a computer-run system of retrieval of climatic data for users.

2. To improve the techniques of retrieving climate parameters from the remotely-sensed data by satellites and to upgrade the program library for data processing so as to derive data of crucial components of the climate system.

3. To prepare a series of technical guides to data input, quality control, data bank management, data center operation and normalized services for users.

V. Major Measures

1. The departments concerned will set up climate-system data service

centers in line with their respective tasks and establish regional centers of data and services to realize the strategic targets of the Climate Data Programme.

2. To transfer the possession of techniques concerning computer hardwares and softwares, including data input, quality control, statistics, access, compilation and products for users in the climate-system data management and services.

3. To introduce an extra-large-size computer, which will help to form a nationwide type-compatible computer network in order to answer the purpose of climate information collecting and product processing in vast quantities in a short span of time, and this will be the base for multi-distributed data banks.

4. To draw up regulations and establish an operational system for the data exchange and services.

5. To train the professional personnel of national and regional centers for climate data services and to qualify them whenever possible, making them catch up with the latest development through lectures, seminars and training courses or by sending them abroad to study or inviting foreign experts to China for a short working visit.

6. To launch activities for data exchange with other countries and to collect important information, data and variation of the climate system.

NATIONAL CLIMATE APPLICATION SUBPROGRAMME

I. Significance

As indicated in the World Climate Programme, climate applications cover practically every scope of human activities. Many fields of production and the life of the public depend on the parameters provided by climatic research for their rational planning and schedule to reach the goals of better economic benefits, security and higher efficiency. As a rule, the output-input ratio in climate applications is more than 2:1 and quite often 10:1.

China is a country with abundant climate resources and frequent climatic disasters. Because of some amount of unawareness in the climate application in the past, not only were serious economic losses caused, but the resources themselves were damaged considerably, leading to higher frequency and more severity of the catastrophes as well.

China possesses a considerable volume of climate data, information and research achievements. If they are exploited and put into operation, then activities, especially in farming, water conservancy and energy production/utilization, can benefit much and climatic catastrophes be greatly alleviated as well.

II. The Status Quo

The Ninth Session of Commission for Atmospheric Sciences approved the World Climate Application Programme (WCAP), following which the WCAP-Food, WCAP-Water, WCAP-Energy and other subprogrammes were formulated one after another. Evidently, their implementation needs efforts of many departments. On the other hand, to provide exchangeable standardized data in the applications, separate Climate Application Reference Systems (CARS) are to be established in the branches concerned together with offering training courses and provision of easily-processed climatic products and publications for users.

China has laid a certain foundation for climate applications. There are, among other things, hydrological and agrometeorological networks covering the country, which have been producing considerable benefit in their services. Good results have been achieved in their application to the building and energy

industries, too. The climate applications have been adopted as a routine practice by some departments in their operation. Further, the utilization in health and medical work, tourism and other fields are just unfolding.

III. The Strategic Targets

1. The exploitation of the climate resources and the prevention of natural disasters in China cover the problems of further exploitation and utilization of the monsoon climate of eastern China and of the arid/semi-arid and mountainous/hilly land, accounting for a large portion of the country.

2. Research is to be made of the application of climate fluctuation to agricultural production and the design of irrigation works, with focus on its utilizations in the layout of agricultural pattern and water conservancy facilities with the aridization trend and greenhouse effects considered.

3. On the whole, the purposes of the three major programmes in WCAP may be applied to China's reality. However, the WCAP-Food will be extended to include "macroagriculture" programme; the WCAP-Water will allow for the prevention of droughts/floods and the exploitation of arid areas; the WCAP-Energy will be performed with the consideration of the rural energy source in this country.

4. The needs of various users will be investigated. CARS's are to be established for different users with a view to getting, step by step, climate applications standardized and informationized, and developing them into important branches of service.

IV. Major Tasks in the Eighth Five-Year Plan Period (1991-1995)

In this period climate applications have the focus on agricultural development and construction of water conservancy facilities, without ignorance of other feasible items in urgent need. They are stated in detail as follows.

1. Research will be conducted of the climate/water resources and potentiality of agriculture, stock-raising and forestry over the arid and semi-arid land in Northwest and North China, with focus on the bearing capacity of water resources to support the population and industrial and agricultural development there.

2. Research will be performed of climatic disasters and the measures for the loss reduction, the emphasis being on droughts and floods as the extreme perils of hydrological and meteorological origin, together with the catastrophe criterion, its regional distribution, causes and mechanism, in order to provide a basis for the loss reduction.

3. Research will be made of the climate fluctuation in relation to the development of agriculture. The dynamic monitoring and research of agroclimate resources and disasters are to be enhanced; agroclimatic forecasts are to be developed and issued in which will be included the research of the theory and methodology for predicting the agricultural output on various scales.

4. Research will be done of the future climatic effect on the modification of water resources in a basin and transbasin to provide background information for the planning of economic growth and the construction and management of water conservancy projects, together with water dispatches in the drainage area.

5. Research is planned of climate resources and catastrophes in the coastal areas under development and the bases of grain, cotton and energy resources. The study is required to be made in connection with the climate application typical of each of the areas in an attempt to produce substantial benefits.

6. Climate energy, building-industry and urban climates have much to do with the urban and rural development, and their studies and applications have achieved some results, which will be put into use in a combined form. On the other hand, the problems that were paid less attention will be given more consideration in this period.

7. On climatic applications will be conducted research of basic nature, e.g., local, micro and boundary-layer climates, and the basic laws of the climate evolution in particular geographic conditions, such as urban environment, water-bodies and deserts, together with the exploration of the theory and methodology of the climate applications for such regions.

V. Major Measures

1. Since many trades and regions are closely associated with climate, it is suggested that the domestic multi-subject survey, investigation, planning and research programmes establish relation with the National Climate Application Programme, which will collect extensively the demands and requests of different users and gather scientists to deal with the problems for better service.

2. The National Climate Application Programme will extensively collect all kinds of information concerning the services and research findings in this field at home and abroad. On our original basis and with consideration of the reality of China scientific workers and facilities are to be gathered to attack some problems in order to make possible their digitization, modelization

and systemization and extension.

3. Some major application projects will be carried out by virtue of efforts on a regional or national basis. It is desirable to cooperate with the users in all application items, and only in this way can the climate application and service be marked by Chinese style and meet the needs of our four modernizations.

4. More efforts are to be put into capital construction, e.g., the establishment, in climatic zones, of networks of experimental bases of various types for different purposes which are of much importance to the national economy. An agrometeorological experimental network, though less perfect, is working well, and it needs to be replenished and improved in carrying out new tasks. The improvement will depend on the financial aid of the nation.

NATIONAL CLIMATE IMPACT SUBPROGRAMME

I. Significance

In recent years the earth's environment deterioration has been going on, leading to the abnormality of its climate. The following deserve our concern: the environment's contamination is getting increasingly worse; acidification of the atmosphere with its fallouts has become one of the major threats to the ecological environment; the increase of atmospheric CFCs (chlorofluorocarbons) and the like results in depletion of the ozone layer, threatening the human health and agriculture; the over-cutting of the forests, the excessive herding and reclaiming in grassland and irrational use of land, have dramatically reduced the size of the forests and vegetation and, as a result, the soil and water loss and desertization follow; the construction of large water conservancy projects, e.g., the huge reservoirs, reclamation of land from lakes and deflection of waterways, also exerts effects on climate variation; the ever-increasing concentration of greenhouse gases from industrial and agricultural sources gives rise to the warming of climate, followed by a series of ecological changes.

Nowadays, the problem of climate impact has entered the world's political and diplomatic field. The 1987 International Conference held in Montreal adopted an international agreement of controlling the production of CFCs to keep the ozone layer from further destruction. The 1988 Intergovernmental Climate-Impact Special Committee sponsored by WMO and UNEP (United Nations Environment Programme) is undertaking the study of greenhouse effect on climate and measures of its prevention.

II. The Status Quo

Following the 1987 decision of WMO Executive Council, major efforts should be focussed on the following aspects for 1988 — 1997:

1. The assesement of effects of variation in greenhouse gases on the climate change and the development of society and economy;
2. The application of the assessment method of climate impact;
3. The cooperation in the study of climate-impact.

In order to obtain reliable data for the human effect on climate change and elucidate the related mechanism, all countries are currently developing their

own background systems for monitoring climate and ecology, the numerical dynamic climate models and diagnosis and simulation experiments for revealing the climatic effect of human activities. Furthermore, in order to investigate the socioeconomic impact of climate change due to human activities, a larger number of countries are developing models for the management of, and assessment of response strategies against socioeconomic impact of climate, and models for evaluating climatic influence on crop yields and cropping systems and its prediction.

China has made certain advances in climate impact study, but much is left to be desired. As regards the background climate monitoring systems, China has only a limited number of third-order stations whose operation needs to be regularized. For the numerical dynamic climate model, China has some simple models, and the more sophisticated ones are being transplanted and developed. Certain progress has been made in the study of climatic impact on economic development, but it needs to be improved.

III. The Strategic Targets

1. To establish an initial-form nationwide climate monitoring background network with one first-order background station to be included.
2. To make preliminary assessment of the effect of greenhouse gases, vegetation and major water conservancy projects on the regional climate.
3. To explore and predict the impact of climate change on the development of the population and economy, especially on the industrial/agricultural productions, ecological system, and on the bearing capacity of the national economy.
4. To work out a series of measures as to the management and control of the climatic and other environmental variation.

VI. The Tasks in the Eighth Five-Year Plan Period (1991 — 1995)

1. To establish an initial-form nationwide climate monitoring background network with one first-order station to be included.
2. To develop regional dynamic climate models, to investigate greenhouse effects on the growth of China's economy, and to estimate the amount of greenhouse gases to be emitted from our country, together with response strategies against the influence.
3. Research into the tendency of droughts and prospects of the water resources in North China with human activities involved, and the corresponding bearing capacity of the climate resources for the economy and population,

together with possible response strategies.

4. To study the bearing capacity of the coastal areas for economic development with anthropogenic climate change and the sea-level change, along with possible response strategies.

5. To evaluate the climatic consequences of transferring water towards the north from the western, middle and eastern parts of the Changjiang River, and getting the Huanghe River water for irrigation, to estimate the possible climate impact of the Gezhou-Dam and the Three-Gorge Reservoir, which is now under consideration, on the development of the society and agriculture/industry.

6. To study the mechanism of the depletion of stratospheric ozone and the increasing concentration of tropospheric ozone, together with their climatic effect on our economy.

7. To examine effect of acid rain and its deposits with their long-distance transport on the economy, together with its response strategies

8. To study historical evolution of forestry and other types of vegetation in China with their effects on the climate and economic development, together with response strategies.

9. To investigate the effect of the global climate change, especially monsoon and the ENSO with its teleconnection event, on the water resources in North China, the drought/flood tendency in middle and lower reaches of the Changjiang River, and coastal zones economically under development in East and South China.

10. To provide the state with consultative reports about the tendency of the climate and ecological environment deterioration in our country, along with the research of management and supervision policies.

11. To make criteria for environment quality and take measures for the gross and dynamic control of the emission of greenhouse gases and pollutants; to investigate the climatic effect of the bearing capacity, rational pattern/layout of industries/agriculture, and major renovation of land under the conditions of the present climate and environment and future changed regime.

12. To study the causes for climatic catastrophes recorded in the history and modern times, together with their impact on socioeconomic development and the remedy measures.

V. Major Measures

1. A group of experts under the climate-impact subcommittee will be responsible for the coordination of the above tasks.

2. Development and operation of regional dynamic climate models and performance of numerical study based on the effect on China's climate of greenhouse gases and changing biosphere due to human activities.

3. Coordination of environmental protection, and other socioeconomic units for integrating investigation.

I. Significance

Climate is a complicated coupled system of the atmosphere, ocean, cryosphere, lithosphere and biosphere. The study of the physical, chemical, biological processes and interactions of its subsystems aims at improving the understanding of the climate formation, its variation features and causes, in order to determine the predictability of climate and the degree of the impact of human activities on it. This will furnish rationale and approaches for its prediction, and present scientific bases for reasonably evaluating the human influence on climate and for making major response strategies against the adverse effect.

II. The Status Quo

The World Climate Research Programme (WCRP) as one of the most important international scientific co-operations in this century has advanced and will advance the climatic research. China has quite a long history of the study of climate and its change, and has made significant achievements in many fields, e.g., East Asian atmospheric circulation and monsoon climate, impact of the Qinghai-Xizang Plateau on atmospheric circulations, historical climate and air-sea interaction. Although the numerical study of climate was started relatively late, substantial progress has been made in the research typical of the Chinese style. In recent years, three climate research projects jointly supported by National Natural Science Foundation of China and Chinese Academy of Sciences and others supported by the Climate Foundations, SMA have given an impetus to the climate research in China. However, owing to the less advanced facilities, the climatic system cannot be well monitored, nor can the fundamental data be collected systematically and adequately. Besides, because of the shortage of an extra-large size powerful computer, a gap remains between China and developed countries in the capacity and speed of data processing, and in the research of climate diagnosis and simulation.

III. Strategic Targets

Combination of efforts towards climatic research in close connection with the need of our four modernizations is of significance to the strategic schedule

NATIONAL CLIMATE RESEARCH SUBPROGRAMME

I. Significance

Climate is a complicated coupled system of the atmosphere, oceans, cryosphere, lithosphere and biosphere. The study of the physical, chemical, biological processes and interactions of its subsystems aims at improving the understanding of the climate formation, its variation features and causes, in order to determine the predictability of climate and the degree of the impact of human activities on it. This will furnish rationale and approaches for its prediction, and present scientific bases for reasonably evaluating the human influence on climate and for making major response strategies against the adverse effect.

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III. Strategic Targets

Combination of efforts towards climatic research in close connection with the need of our four modernizations is of significance to the strategic schedule

of the national construction. In addition, the climate diagnosis/simulation represents one of the frontiers in climatological sciences, which will help us further understanding the mechanism of the formation and variation of the complicated climate system and increase the ability to predict climatic variations on monthly, seasonal and interannual and longer-term scales. The main tasks are stated as follows.

1. To understand the regularities and causes of the frequency and intensity of large-scale climatic catastrophes, mainly persistent droughts, floods, cool injuries and extreme climatic events in China, to establish the rationale for short-term climatic oscillations and to improve the skill for the prediction of the monthly- and seasonal-scale climate evolution.

2. To detect strong signals of climatic variation with particular focus on the ones of the transitional and sensitive zones and to establish theory of the climatic phase and its catastrophe which is then used for climatic prediction on an annual and longer-term basis.

3. To monitor and explore the impact of human activities on climate and its natural change in order to produce its long-range variation theory, whereupon the tendency of its development in China is predicted for 50 years to come on the global-climate background, with a view to providing scientific basis of climatic evolution for the strategic schedule of China's construction.

VI. Major Tasks in the Eighth Five-Year Plan Period (1991 — 1995)

1. To investigate the formation and regularities of the occurrence of major climatic disasters in China, together with their prediction techniques

To enhance, in a combined effort, the study of drought/flood and cool injuries in eastern China, and starting from atmospheric dynamics and anomalies of the sea and land-surface thermal status to examine the physical causes for the formation of catastrophic climate and to construct a three-dimensional model with the conditions of the atmosphere, oceans and land surface to be involved; to further develop statistical and synoptical approaches and intensify the study of dynamical prediction techniques.

To investigate the precursors of significance to prediction in some early warning areas for large-scale climatic variation. For example, the large-scale persistent catastrophic climate usually demonstrates strong presages, of which a breakthrough should be made first in climatic prediction. It has been found that the tropical 30 — 50 day low-frequency oscillation, ENSO and the quasi-biennial oscillation are the strong signals that are considerably beyond the noise

background, which should be applied in monthly, seasonal and interannual scale predictions. Besides, it is of great significance to apply regularities of catastrophic climate and the condition for its transition to climatic prediction.

2. The study of the drought-forming conditions and their trend in Northwest China

Northwest China situated in the hinderland of the Eurasian continent is one of the driest areas in China and the world. The study of the evolution of the droughts there is of much importance to the growth of economy.

Based on the detailed analysis of the historical evolution of the aridity in this area, the observational and experimental study will be made of the land-air interaction, and investigation of water-vapour sources, water and heat budget, together with the impact of human activities on the near-surface-layer processes, in order to determine the circumstances responsible for the drought in this area. Study will be conducted of the existence and the historical evolution of the Qinghai-Xizang Plateau in relation to the formation of droughts of Northwest China, and of the relationship between the occurrence of these droughts and the global climatic change on large-scale. Major efforts will be directed towards a qualitative estimate of the tendency of the aridity in Northwest China in 20 — 50 years in advance, which is planned to be done within 5 years.

3. The study of the important processes in climatic change

Persistent efforts are needed for the study of the interactions among physical, chemical and biological processes in the well-coupled complicated climate system. In the five years to come, the study will be intensified in the following aspects.

1) The dynamics of the low-frequency variation of the atmosphere

To enhance the observation and analysis of atmospheric low-frequency oscillations, e.g., 30 — 50 day, semi-ennial, quasi-biennial oscillations and Southern Oscillation, together with the theory of their formations, and related teleconnections; to investigate planetary wave and its propagational dynamics, the nonlinear process in the atmosphere and the catastrophe theory.

2) The study of air-sea interaction

To place emphasis on the study of the air-sea interaction over the tropical western Pacific and South-China Sea that are of primary importance to the climate of the country and inaccessible for others and to perform integrated research involving monitoring, special observation, and diagnostic analysis combined with numerical simulation; to measure, calculate and analyse the

momentum, energy and mass exchanges between air and sea and at the air-sea interface; to investigate the interaction between monsoon activities and tropical oceans, along with the examination of tropical impact on the midlatitude atmospheric circulation, with the aim of making contribution to the international TOGA programme.

To reinforce the study of the extratropical air-sea interaction and that between sea ice and climate; to combine the observational means e.g., the coastal hydrometeorological network, buoy system, in-situ ship observation and satellite remote-sensing to perform a long-range monitoring of the sea environment; to develop numerical calculation and simulation of the global and regional oceanic circulations in order to make some contribution to the WOCE (World Oceanic Circulation Experiment) Programme.

3) The impact of the cloud-radiation interaction on climate

Cloud and radiation are important factors in climate formation which have been a weaker link in China's climate research. We will take an active part in the International Satellite Cloud-Climate Project (ISCCP), to develop climatology of the global cloud distribution and its changes, and improve the cloud parameterization scheme in the climate modelling. Further, we will intensify the study of regional cloud-radiation climatology for our country and of impact of aerosol on the radiation in order to provide scientific basis for the design of regional climate models.

4) The study of the interaction between climate, land processes and ecological system

The vegetation, snow cover, land use, and the related physical properties, e.g., albedo, roughness and moisture, affect the exchange of energy and mass between surface and atmosphere, thus influencing the atmospheric circulation and climate.

We shall intensify the study of the climatic effect caused by changing surface conditions due to human activities, conduct long-term fixed-point observation in different ecological systems, establish the coupled atmosphere-vegetation-soil model, develop a three-dimensional climate model with land processes to be included, and carry out their sensitivity experiments.

5) The study of the impact of greenhouse gases on the climate

The effect caused by the increase in carbon dioxide, methane and other greenhouse gases and the variation of ozone content in the atmosphere repre-

sents one of the main forms of human impact on climate. Above all, the variation of these gases in amount is to be examined through ground-based and space-based probing means, together with the impact on the global, especially China's climate.

In the near future, stress should be on the study of the variations of carbon dioxide, methane and ozone in the atmosphere, their physical properties and the mechanism for their impact on climate. Their impact on climate is to be investigated by our own climatic models and the atmospheric ones available.

In addition, study will be conducted of the climatic effect of the variation in astronomical factors, e.g., solar activity and the earth's parameters.

4. Investigation of the history and regularity of China's climate change for the last 1 000 years

It is a basic job of great significance and typical of Chinese style to establish historical time sequences of the climatic change in China for the last 1 000 years by using the climatic change information recorded in our vast accumulation of ancient literature and in oceans, geology, geography, glaciers, deserts, living things and the atmosphere itself. The cooperation among different sciences will be reinforced and the analytical methods should be made even more objective and quantitative.

5. The numerical simulation of the climate

To develop and upgrade the existing atmospheric circulation models to produce better air-sea and earth-atmosphere coupled models and try to construct stepwise a complete model for the climatic system including biological processes; to improve the parameterization schemes for different processes; to conduct the climatic sensitivity experiments, with a view to exploring approaches for climate numerical prediction; to direct effort to the study of the paleoclimate simulation in order to discover the mechanism of the climatic change.

6. To conduct the study of the coupling between the dynamic process of climate and biogeochemical cycle, in order to combine the study of the climate with that of the global environmental change, with a view to developing a separate geoscience in which the earth and its environmental change are taken as a whole.

V. The Major Measures

1. To intensify the climate monitoring; to select some special items for observation and experiment; to take full advantage of satellite for monitoring the global climatic system.

2. To accelerate the pace of the modernization of the climatic data col-

lecting and processing, and to establish multi-discipline climatic data bank for research purpose.

3. The research items in this programme are of basic nature, and it is suggested that they be included as key projects in the national research programme.

4. To enhance the multi-discipline and the international cooperation in the climatic research.

In the past decade there has been found an interrelation between the anomalies of the global atmospheric circulation and the tropical SST on monthly to annual scales, especially the El Nino events, which represents an air-sea coupled system that involves both the response of the global atmosphere to the tropical SST anomaly, and the response of the tropical oceans to the atmospheric circulation anomaly. The Tropical Ocean and Global Atmosphere (TOGA) programme aims at observational and numerical study of the air-sea coupled system in order to further understand the mechanism of its variation on the time-scale of months to years, assess the existing air-sea coupled models available and likely to be produced, and improve the ability to predict changes in the climate system.

II. The Status Quo
The international TOGA programme spanning 1985—1994 constitutes one important part of World Climate Research Programme (WCRP), which is supported and appreciated by WMO, IOC (Intergovernmental Oceanographic Commission) and ICSU (International Council of Scientific Unions). Many countries have founded their state-level TOGA committees. China began her special TOGA committee in 1987, responsible for arranging and coordinating the nationwide research project and planning the schedule relating to the interaction of the tropical oceans and global atmosphere, and for harmonizing the research with the international TOGA programme and other activities in this field with other countries.

Since 1985, systematic observation and study (with the inclusion of Sino-U.S. joint research) have been undertaken in China regarding the tropical western Pacific air-sea interaction.

The western Pacific has the highest sea temperature on the globe. With the advance in the TOGA research in recent years, people are beginning to understand that this extensive warming pool is one of the "centers of action" of the air-sea coupled system, which is of importance no less but even more than the equatorial eastern Pacific as the origin of the El Nino event. Therefore,

TROPICAL OCEAN AND GLOBAL ATMOSPHERE RESEARCH SUBPROGRAMME

I. Significance

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TOGA COARE (Coupled Ocean-Air Response Experiment) has been recently proposed by a few countries headed by U.S., which focuses effort on the study of the function of the tropical western Pacific as the warming pool. This suggests that the focus of the TOGA project has been shifted, indicating that the air-sea coupled interaction in this region is of vital importance to China's and the East Asian climate research. We shall take advantage of the opportunity to carry out the COARE project as the key item of China's TOGA subprogramme in 1991-1995.

III. Strategic Targets

The strategic target of China's TOGA subprogramme is to investigate and further define the basic physical characteristics of the air-sea interaction on scales of months to years between the East Asian climate variation, on one side, and the SST conditions of the tropical western Pacific, the western North Pacific and the waters off China's coasts, on the other side, to look into its physical processes, and, thus to establish realistic oceanic models, atmospheric models and air-sea coupled models.

Oceanologically, the target is to describe the intermonthly and interannual features of the surface-layer sea temperature, salinity, density and flow fields in the tropical western Pacific west of 180° between 20°N — 20°S , to gain insight into the response of the tropical western Pacific to the ENSO, to explore the relation between the variation of the China's coastwise and offshore sea condition and that of the tropical western Pacific, the response of oceans to the climatic variations, and the problem of parameterization of oceanic models.

As for observation of the ocean-atmosphere boundary layer, it aims at the design and improvement of direct observation of momentum, heat, moisture exchange at the ocean-atmosphere interface to find out the physical processes inside, and to improve the calculating methods for the three fluxes and their parameterization schemes.

The TOGA data bank will be established with the software products for users, which makes it possible to provide better services in predicting the SST and climate anomalies.

The development of the air-sea coupled model aims at simulating the large-scale variation of the tropical oceans (including their large-scale response to the atmospheric forcing), and investigating its physical mechanism and causes, especially the laws and causes of the variation in the "warming pool" and its function in heat redistribution in the sea and atmosphere on the months-

to-years scale.

The sensitivity of the global atmosphere to the heating field of the tropical oceans will be evaluated, and the atmosphere-ocean coupled models developed and/or improved, with a special emphasis on the coupling between atmospheric and oceanic models.

VI. The Tasks in the Eighth Five-Year Plan Period (1991-1995)

In order to realize, step by step, the strategic targets of the TOGA, the following tasks will be fulfilled in this period.

1. In-situ observation and experimentation

The key area in China's TOGA is the tropical western Pacific, with the experimental region covering the 20°S-40°N tropical western and central Pacific.

Programmes for this purpose will include in-situ vessel observation, satellite remote-sensing, research of the application of observational facilities and methods, and island, offshore and bouy station observations and auxiliary observation at merchant ships.

2. Data project

An oceanographic climate data bank will be established with software products to be developed to ensure the in-time access of the reliable marine climate data, and to provide standardized data for marine climatological research.

3. Air-sea interaction research programme

On the basis of analysis of the historical data and in-situ observations, the stress will be on the exploration of air-sea interaction of interannual-scale, which includes the interplay occurring in the SST anomaly in the tropical western Pacific, on one side, and in eastern Asian atmospheric circulation and monsoon circulations and the western Pacific circulation, on the other side. Associated with this is the laboratory research which is to be enhanced. By improving the understanding of the fundamental physical processes of air-sea interaction, the physical background and key points are derived for forecasting ENSO events and large-scale climatic anomaly in China. Included in this programme are: studies of the sea-atmosphere boundary layer, ENSO events, the surface-layer conditions of the ocean, interaction between tropical oceans and monsoon circulation and air-sea mass exchange.

4. The development of the atmosphere-ocean coupled model

It has been planned in the period of 1991 — 1995 to develop a complete atmosphere-ocean coupled model, which can be used to simulate quite well the interannual variability caused by strong signals (e.g., ENSO) in the tropical air-sea system, to perform research of sensitivity and prediction experiments of various types, which are associated with the improvement of atmospheric general circulation model (AGCM) and the oceanic general circulation model (OGCM) along with their coupling, the research of assimilation of 4-dimensional oceanic data, and the performance of experiments by the air-sea coupled model (as part of the objectives of the COARE project).

5. The research on the regularity of marine climate variation of catastrophic nature

We will enhance the study of the marine climatic catastrophe in the coastal regions that are economically developed ones of China, so as to provide better service for the development of national economy.

6. The monitoring and prediction of the sea-level change, together with its response strategies

According to scientists concerned, the world's sea level will rise 0.2 — 1.4 m by the year of 2025. It is a great concern of Chinese government because most of its highly-developed and densely-populated cities are located in the low-lying coastal regions. Therefore, the study of the sea-level change and the way to predict it is a very important task, in which included are the sea-level monitoring, the study of sea-level variation regularities with the predicting methods and response strategies.

V. Major Measures

1. To complete the strategic targets of the TOGA subprogramme, China's special committee on TOGA takes charge of coordinating the transdiscipline and transdepartmental scientists who will be involved in the subprogramme.

2. It is needed to keep a close contact with the international TOGA programme and other international organizations related and to take an active part in the international academic exchange.

3. It is hoped that this subprogramme or some of its subjects can be included as key items in China's state science and technology programme in the period of the Eighth Five-Year Plan (1991-1995), and sponsored by the government to ensure that this major state-level task be accomplished as planned.

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